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STUDY OF POTENTIAL FOR MOTOR VEHICLE FUEL ECONOMY IMPROVEMENT

ECONOMICS PANEL REPORT NO. 5

TRANSPORTATION SYSTEMS CENTER

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16. Abstract

This Economics Panel Report is Number Five (5) of a group of seven (7) prepared by special panels of the Task Force established under the joint chairmanship of DOT and EPA to conduct a study of the practicability of a fuel economy improvement standard of 20% for new motor vehicles produced in the 1980 time frame.

This report analyses the economic effects automobile fuel economy improvement will have on the automobile industry, the American consumer, and the U.S. economy in general. Some specific conclusions are that

1. Consumers will generally experience savings on fuel and maintenance expenditures which more than offset the increases in car prices due to the fuel economy improvements.

2. Automobile sales are expected to increase in the 1970's and 1980's although the rate of increase is expected to be slower than in the past, with a shift back towards standard-size cars.

3. Petroleum savings could range from 0.9 to 1.5 million bbl/day by 1980, from 1.6 to 3.0 by 1985 and from 1.9 to 4.0 by 1990.

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Economics Panel Report

Table 15 on page 30, omitted in this copy, is shown below:

Table 15 IMPACT ON ANNUAL OIL IMPORT COSTS AT $11/bbl
(billions of dollars per year)

		SCENARIO			
YEAR	BASELINE	A	B	C	D
1975	0	.4	.4	.4	.4
1980	0	3.6	4.0	4.8	6.0
1985	0	6.4	8.4	8.8	12.0
1990	0	7.6	12.0	10.8	16.1

1a/

PREFACE

This Economics Panel Report is Number Five (5) of a group of seven (7) prepared by special panels of the Task Force established under the joint chairmanship of DOT and EPA to conduct a study of the practicability of a fuel economy improvement standard of 20% for new motor vehicles produced in the 1980 time frame. Each panel addressed a major impact area and drew on a variety of sources in preparing its report, including previous DOT and EPA research, and industry and public comments.

Materials developed by the various study panels were used in preparing the Report to Congress entitled "Potential for Motor Vehicle Fuel Economy Improvement", dated 24 October 1974 (second printing, 18 November 1974). Assumptions and conclusions expressed in the panel reports, however, are those of the respective panels and do not necessarily reflect official positions or policies of the U.S. Department of Transportation, the U.S. Environmental Protection Agency, or the study Task Force.

The complete Panel Reports set consists of the following:

Report No. 1: Policy Assessment Panel Report
Report No. 2: Safety Implications Panel Report
Report No. 3: Air Quality and Emissions Panel Report
Report No. 4: Technology Panel Report
Report No. 5: Economics Panel Report
Report No. 6: Fuel Economy Test Procedures Panel Report
Report No. 7: Truck and Bus Panel Report

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1. SUMMARY

The Technology Panel Report identifies a set of automobile improvements which are associated with more than a 20% improvement in the fuel efficiency of 1980 vehicles relative to 1974 vehicles. The Economic Panel analysis presented in the following pages, indicates that these improvements, along with other emission related changes, can be implemented by the domestic automobile industry, and would provide several important benefits for the industry. In addition, some positive effects on consumers and the United States economy are identified. Several specific conclusions are given below:

1. Consumers will generally experience savings on fuel and maintenance expenditures which more than offset the increases in car prices due to the fuel economy improvements. Although the present value of these net savings will typically amount to hundreds of dollars over the lifetime of the car, these dollar savings are not necessarily large enough to offset price increases due to meeting future emission, safety and damageability standards.

2. Automobile sales are expected to increase in the 1970's and 1980's although the rate of increase is expected to be slower than in the past (the higher prices which reresult from emission, damageability, and safety related changes were among the factors taken into account when these sales forecasts were made). The effect of the potential fuel efficiency improvements would likely be to increase sales to levels slightly above the basic trend, or at worst leave the trend essentially unchanged. It is <u>not</u> expected that industry sales will decline because of mandated fuel economy improvements, based on cost estimates used in this report.

3. In spite of somewhat higher vehicle prices, anticipated fuel economy improvements are expected to encourage a sales shift back towards standard-size[1] cars in the absence of other countervailing pressures.

4. Related industry impacts and macroeconomic effects are small because of the expected upward trend of total sales in real dollars.

5. The additional investments in retooling to implement efficiency improvements total only about $1.0 billion through 1980 (this assumes that there is no additional shift to smaller cars after 1975). This sum is small in comparison with the normal capital spending of the industry. Financing these expenditures will not pose a restraint on implementation given a gradually rising level of auto sales.

6. Petroleum savings could range from 0.9 to 1.5 million bbl/day by 1980, from 1.6 to 3.0 by 1985 and from 1.9 to 4.0 by 1990. These may be thought of either as reductions in the quantity of oil imported with annual multi-billion dollar balance-of-trade benefits or as reductions in the demand imposed on domestic supplies. In the latter case, substantial investments in fuel production facilities can be avoided--investments whose magnitude exceeds those required for auto retooling by a factor of at least three.[2]

Table 1 summarizes some of these points for several scenarios defined in the next section.

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[1] "Standard-size" refers to the relatively large and expensive "full size" vehicle. It usually is thought of as a six passenger car.

[2] This results is based on calculations made at DOT/TSC and described in an internal memorandum by John K. Pollard titled "Capital Investment Implications of Mandatory vs. Voluntary Auto Efficiency Programs" (November 27, 1974).

TABLE 1. SUMMARY OF ECONOMIC IMPACTS

Scenario	Net Present Value Consumer Savings, 1980 Model Year[a] ($/car)		Average Annual Incremental Investment ($ Millions)		Total Gasoline Consumption (Billions of gallons)		Annual Import[b] Savings ($ Billions)	
	Subcompact	Standard	1978-1980	1981-1985	1980	1985	1980	1985
A MODEST IMPROVEMENTS	330	1,100	10	None	80.4	85.6	3.8	6.5
B RADICAL IMPROVEMENTS (1980's)	1,1	1,1	94	528	69.1	74.2	4.9	8.5
C MAXIMUM IMPROVEMENT BY 1980	745	1,490	175	None	76.6	76.8	5.0	8.9
D SCENARIO B PLUS SHIFT TO SMALLER CARS	NA[c]	NA[c]	140	528	55.1	60.0	6.0	12.0

(a) Present values calculated over 10 years using a 10% discount rate and a price of 55¢ per gallon for gasoline.

(b) Imports valued at $31 per bbl.

(c) Not calculated because incremental retail prices could not be estimated.

2. SCENARIOS OF FUEL ECONOMY IMPROVEMENTS

An effort is made in this report to cover a range of fuel economy improvement scenarios. A summary description of the scenarios is provided in Table 2.

Several points regarding these scenarios should be mentioned. First, Scenarios B and D include conversions to diesel engines, although there is considerable uncertainty as to whether diesel engines can meet the statutory NO_x emission requirements without sacrificing some fuel efficiency. There are also reservations regarding consumer acceptance of the diesel. Current diesel engines are associated with odor, noise, and other problems. Second, the sales shift in Scenario D would probably not occur "voluntarily" because of market demands for larger cars; i.e., Scenario D would probably require more substantial government pressure on manufacturers and/or consumers than would be the case under Scenarios B and C.

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TABLE 2. SCENARIO SUMMARIES

Scenario	PERCENT GAIN IN MPG (1)		FUEL ECONOMY IMPROVEMENTS
	1980	1985	
Baseline	0	0	No improvements in fuel economy relative to 1974 vehicles. Minimum changes to meet statutory emission standards.
A Modest Improvements	28%	27%	Optimized conventional engines, radial tires, slight weight and aerodynamic drag reductions (in line with announced industry goals). No improvements after 1978.
B Gradual Improvement Thru 1980's	33%	32%	Steady technological improvement through the 1980's: Weight reduction through materials substitution and minor redesign during the 1970's; further changes (unitized body) in the 1980's. Some aerodynamic drag reduction and substantial transmission improvements fully accomplished by 1984. Diesel engines phased in for larger cars from 1981 to 1989 plus some stratified charge engines for smaller cars. No performance degradation.
C Maximum Improvement by 1980	45%	41%	Maximum rate of improvement through 1980 with little further gain during the 1980's. Rapid weight reduction, aerodynamic drag reduction, and transmission improvements. Displacement reduction of optimized conventional engines, but no diesel or stratified charge engines.
D Scenario B Plus Shift to Smaller Cars	63%	84%	Same as B with 1980 sales mix assumed at 10 percent large cars, 25 percent intermediates, 25 percent compact, and 40 percent subcompact.

1) Sales weights used given in tables 6 to 9.

3. CONSUMER IMPACTS: AUTOMOBILE PRICE AND FUEL CONSUMPTION

The impacts on the individual consumer will vary depending on the specific vehicle purchased, so it is necessary to consider the consumer impacts for each major size category of automobile available. The size categories used are subcompact, compact, intermediate, standard, and luxury. In this section, the different size classes represent different price/fuel efficiency combinations.

Although the analysis focuses on 1980 vehicles, the numerical results also apply to any vehicle built in any year if it embodies the same price and fuel efficiency characteristics.

3.1 OPERATING COSTS

In estimating the consumer impact for a given class of vehicle, we begin by taking the annual mileage numbers used in the FHWA report, Cost of Operating an Automobile (April 1974). The annual mileage estimates used are held constant for all size classes of vehicles. The actual numbers used are given in Table 3.

TABLE 3. ANNUAL VEHICLE MILEAGE PER AUTOMOBILE BY AGE

YEAR (AGE)	MILEAGE
1	14,500
2	13,000
3	11,500
4	10,000
5	9,900
6	9,900
7	9,500
8	8,500
9	7,500
10	5,700
TOTAL	100,000

Under these assumptions, the consumer impact of fuel economy improvements depends on the relationship between the (probable) higher initial price of the fuel efficient vehicle and the reduced operating expenses. In order to compare these two factors, it is necessary to convert the dollar amounts to a common time frame. This is accomplished by discounting (or taking the present value of) the fuel economy savings to the present so they can be compared to initial selling price.

Figures 1 to 3 show the relationship between fuel efficiency (MPG) and the present value of fuel costs under various assumptions. All computations were made using the FHWA mileage distribution given in Table 3. Figures 1, 2, and 3 use 5%, 10%, and 20% discount rates respectively, and each line shows for a specified gas price (P) the present value (PV) of the fuel costs involved in driving a vehicle 100,000 miles over ten years assuming that each year's gas is paid for in the middle of the year. For any line, the difference in vertical distance corresponding to any two MPG numbers is the present value of the fuel savings due to a shift from the lower to the higher MPG. The present value of the fuel costs associated with a given MPG can be quickly calculated by using the appropriate estimating equation shown in the legend to each figure. In this way, the value of the fuel savings for any size class can be found for any scenario if the initial and improved MPG data are known.

For example, using a 10% discount rate and a 55¢ per gallon price of gas, the present value of the fuel costs associated with driving a 1974 standard size vehicle under Scenario C is $3,696 (PV = 37,696.8/10.2 MPG), while the 1980 costs are $2,299 (PV = 37,696.8/16.4). The difference is $1,397 and this represents the value of the 10 year savings in fuel costs due to the operation of the more fuel efficient vehicle (See column 3 of Table 4). A 20% discount rate changes the result to $1140.

This information can be combined with estimates of changes in maintenance costs and changes in initial purchase prices. In this way, the net impact on the consumer can be estimated. Table 4 presents these calculations for 1980 vehicles under Scenario C.

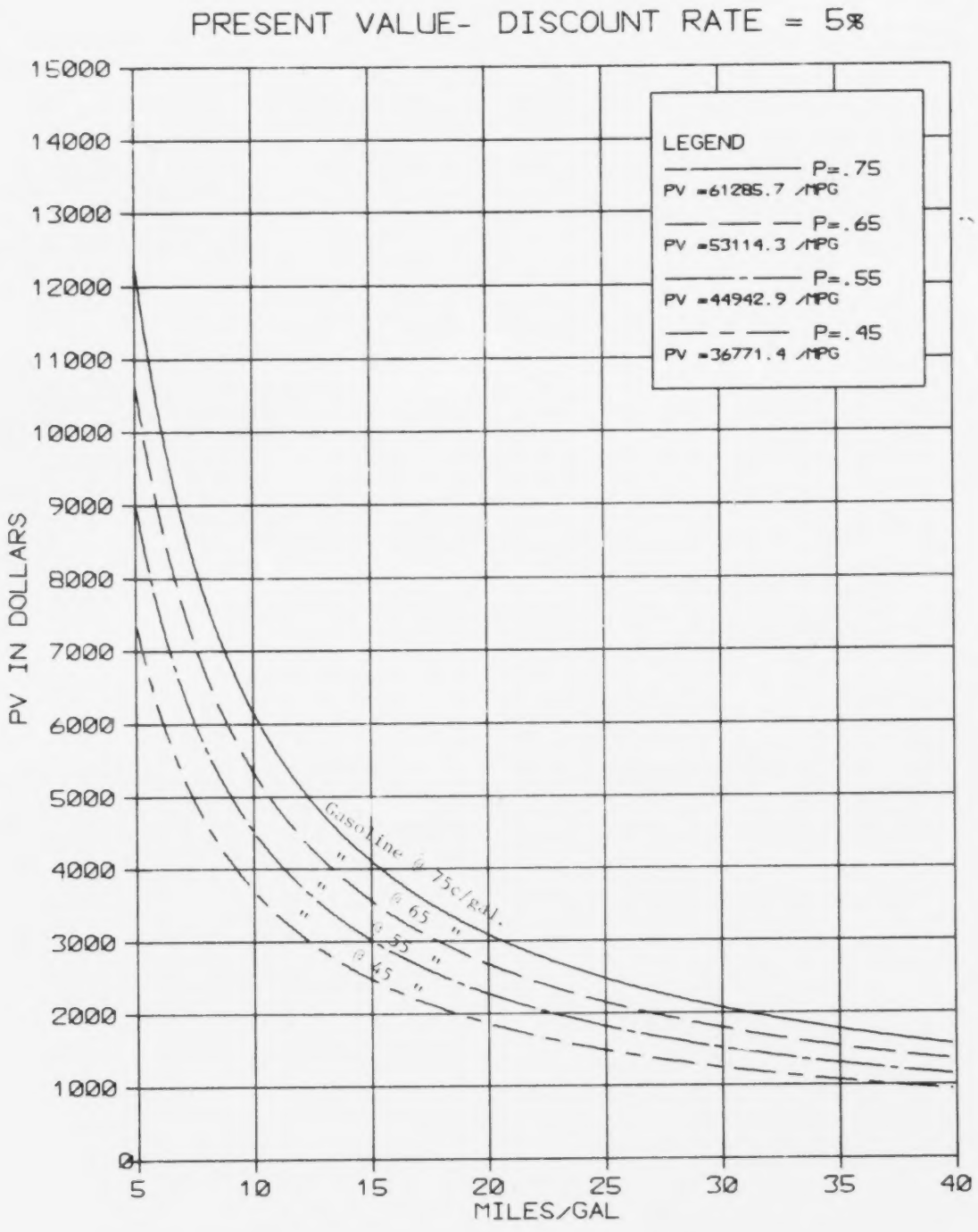

Figure 1 Fuel Efficiency versus PV at 5% Discount Rate

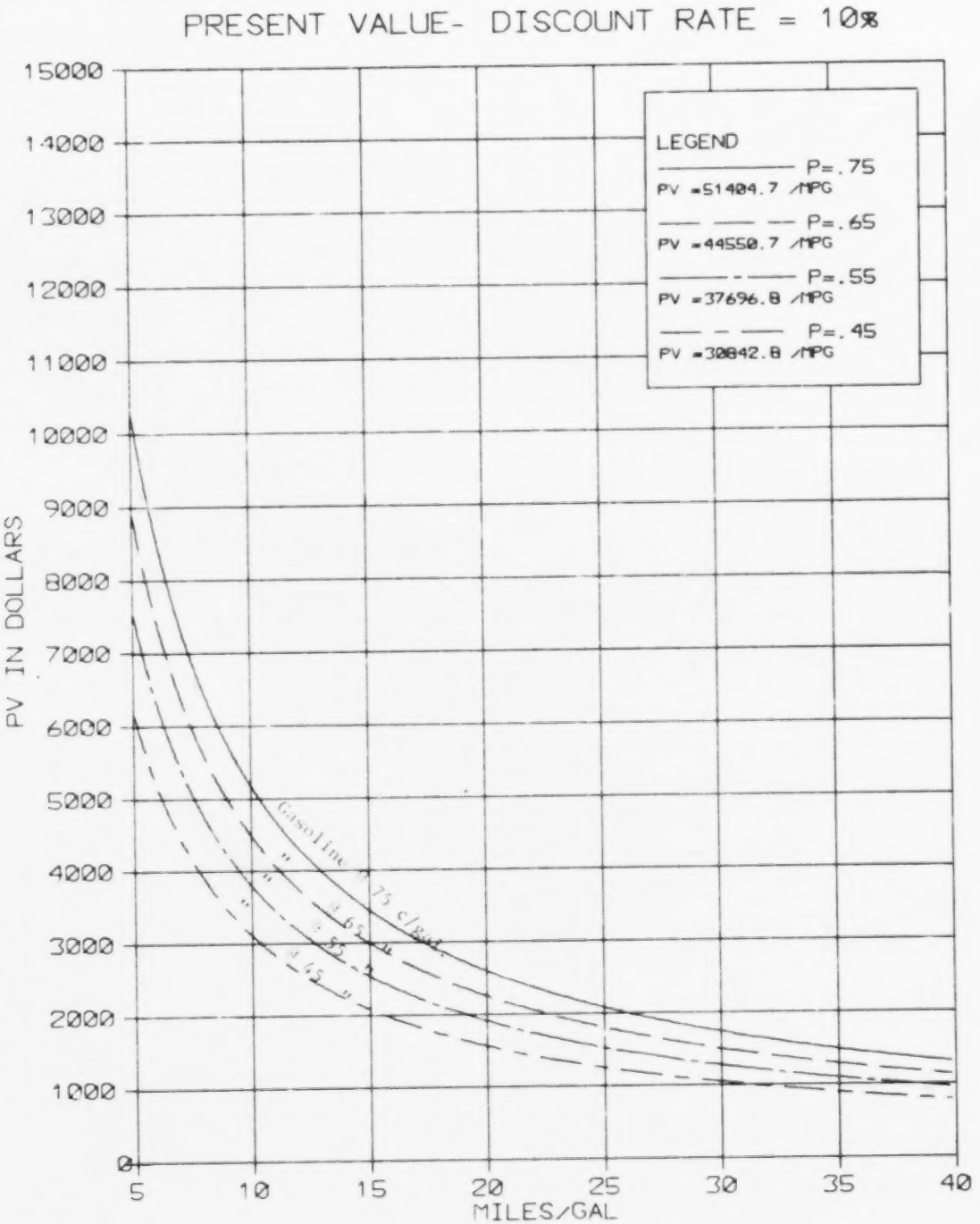

Figure 2 Fuel Efficiency versus PV at 10% Discount Rate

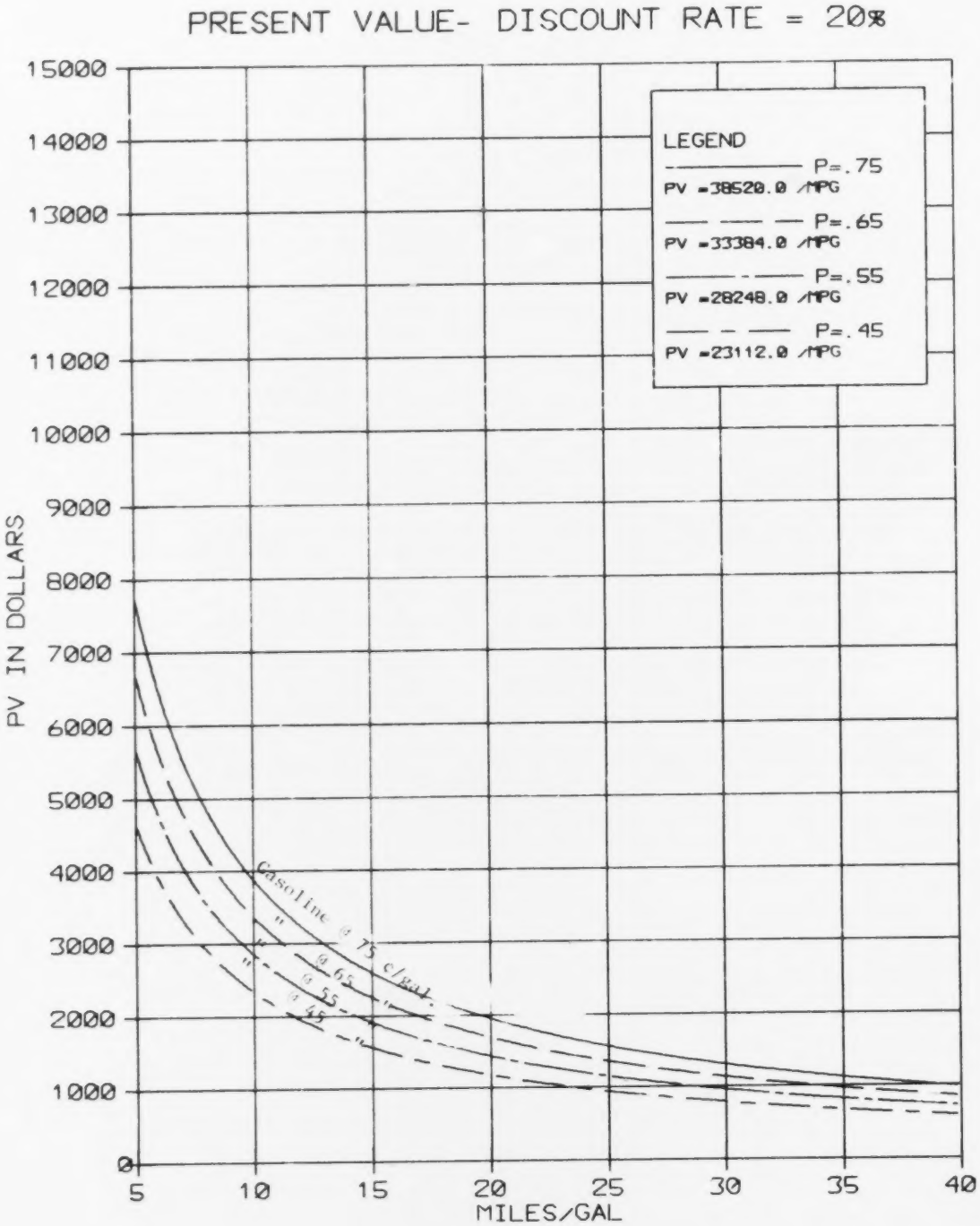

Figure 3 Fuel Efficiency versus PV at 20% Discount Rate

TABLE 4. ESTIMATED 1980 IMPACTS OF FUEL ECONOMY IMPROVEMENTS UNDER SCENARIO C (DOLLARS/CAR)

	Gain in MPG	Increase in Initial Price (1)	PV of Fuel Savings	PV of Maintenance Savings	Net Savings
SUBCOMPACT	24.4	242	535	213	306
COMPACT	42.6	249	688	308	747
INTERMEDIATE	42.6	249	937	308	966
STANDARD	61.0	296	1,397	389	1,490
LUXURY	61.0	296	1,465	389	1,558

1) Price increases are approximations based on data provided by the Technology Panel in September 1974. Later refinements of this data appear to have little affect on "net savings".

Thus, for a standard size vehicle, in addition to the savings on fuel, there are maintenance savings of $389, but a purchase price which is $296 higher. The net result is a savings of $1,490 ($1,397 plus $389, minus $296). Table 5 presents the results of these calculations for other fuel economy improvement scenarios. Table 4 and 5 indicate that there are large net savings to consumers from the hypothesized fuel efficiency improvements, i.e., the benefits are much greater than cost. It should be emphasized that the costs are the extra dollars included in the retail prices of automobiles for fuel efficiency improvements alone; in so far as possible the costs of safety, damageability, and emission control were excluded. For a standard size vehicle under Scenario C the savings in fuel and maintenance expenditures offset the extra costs at about 15,000 miles or after about one year of normal use. For a subcompact car the savings offset the extra costs at about 40,000 miles or after about three years of normal use.

TABLE 5. NET PRESENT VALUE SAVINGS FROM THE PURCHASE OF FUEL EFFICIENT VEHICLES (DOLLARS/CAR)

	SCENARIO				
CAR SIZE	A	B	B *	C	C**
SUBCOMPACT	330	374	513	306	354
COMPACT	612	685	873	747	838
INTERMEDIATE	868	911	1,510	996	1,117
STANDARD	1,103	1,217	1,824	1,490	1,504
LUXURY	1,151	1,276	1,900	1,558	1,543

* Post 1980 vehicles with diesel engines, etc. ** 1982 vehicles

It should be pointed out that since these estimates (and the others included in Tables 4 and 5) involve future events they are only approximations based on presently available information. There is some uncertainty regarding several aspects of the underlying calculations and estimates, but it is unlikely that better information will change the general conclusion that significant savings would be realized by consumers. Some additional comments about Tables 4 and 5 may help in their interpretation.

First, the estimation of the present value of fuel cost savings was described above for standard size vehicles under Scenario C. The important variable in this calculation is the percent improvement in fuel economy. The Technology Panel Report describes the various potential improvements and their approximate impacts.[1]

Second, the maintenance savings were estimated by comparing maintenance schedules before and after engine modifications, and with and without radial tires. Discounting of future expenditures was used in all cases. No adjustment was made for the possibility of additional unscheduled maintenance of new components.

Third, vehicle price changes due to equipment changes were estimated in the Technology Panel Report.[2] Depreciation and interest charges on new capital equipment were included. Price increments were limited to those changes aimed at improving fuel economy, and therefore, they do not reflect the full range of price changes expected because of cost increases due to emission controls, safety standards, and other factors. Under Scenario D there is an extreme shift to smaller cars and it is unlikely that this can be achieved without adjusting relative prices among size classes. Specifically, the price differential between large and small cars would have to be increased (presumably by raising prices of larger cars and lowering prices of smaller cars) in order to induce some

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[1] Technology Panel Report for "Potential for Motor Vehicle Fuel Economy Improvement", EPA/DOT (Washington: 1974), pp. through 5-18.

[2] Ibid., Tables 5-4, 5-5, and 5-6 on pp. 5-8 through 5-11.

buyers to purchase smaller rather than larger cars. Since no estimates of these price realignments are available, it was not possible to estimate price increments for Scenario D, and thus no net savings estimates were made.

Fourth, using a 20% discount rate reduces the net savings estimates of Table 4 by about 20 to 30 per cent, i.e., the size of the savings is reduced somewhat but the basic pattern and general conclusions are unaffected.

The impact of fuel economy improvements on consumers has been studied under the assumption of a single owner operating a vehicle for 100,000 miles over 10 years. Although this assumption is not met in a large number of cases (witness the used car market), this limitation does not represent a serious flaw in the analysis. Some additional explanation may serve to clarify this point.

Used car prices reflect the expected quantity and quality of transportation available from a vehicle as well as some adjustment for future expenses. Two cars which are of the same make, model and age will have different values depending on their condition. A buyer will pay less for a vehicle if he knows he must soon bear the expense of replacing the tires. Similarly, if it is known that a given vehicle has poor fuel economy, the extra fuel costs become an anticipated expense associated with the purchase of that car, and the value of the car is thereby diminished. Thus, changes in operating costs will be reflected in used car prices. In the case of improved fuel economy, the used car has some extra value because of its lower operating costs, and this is reflected as an increment to the price paid by the second owner. The extra amount paid then becomes an offset to the used car buyer's lower operating costs. Since the amount of change in used car value due to fuel economy improvement cannot be measured, it is impossible to estimate the <u>net</u> impact on the used car buyer of (1) the lower operating costs, and (2) the higher price. An analogous argument can be made regarding the <u>net</u> impact of lower operating costs and higher resale value on the used car seller.

Instead of treating the cases of the first and subsequent owners separately, the approach taken was to consider them together. In this way, the net consumer impact of fuel economy improvements was measured, although the way in which the impact was shared among new and used car buyers is not known. As can be seen in Table 5, there were significant net benefits accruing to the consumer whether he is assumed to be a single person or a series of owners.

4. AUTOMOBILE INDUSTRY IMPACTS

The fuel economy improvements discussed in this study affect the auto industry through their impact on industry sales and industry investment.

4.1 SALES IMPACT

The impact on sales is a result of two opposing forces. The first, higher price due to the additional costs of equipment and design, tends to reduce total sales. The other, lower operating costs due to the improved fuel efficiency tends to increase sales.

Several forecasts of auto industry sales generated by well-known research firms were available for this study and each indicated 1980 auto sales will be at least two million above the present level. However, each forecast is inadequate on one particular point. The forecasting models used, which are generally components of larger macro-economic forecasting models, are sensitive to income, new car prices and gasoline prices. A rational consumer should be concerned with total fuel expenditures - the product of gasoline price and vehicle fuel efficiency - and not just gasoline price itself. For example, a technological improvement which increases fuel efficiency 20% and which causes a 1% increase in new car prices is a negative impetus to car sales in these models because of the price increase, with no offsetting positive impact from the fuel savings. Similarly, a 20% gas price increase coincident with a 20% fuel efficiency increase leaves a car buyer the same out-of-pocket gas costs per mile driven, but most sales models would shown reduced sales because of the higher price of gas.

This point is particularly important to this study because the policy scenarios which include rising car prices are very much fuel efficiency-oriented.

In response to this problem, an aggregate auto sales model has been calibrated at the U.S. Department of Transportation, Transportation Systems Center (DOT/TSC) using gasoline price adjusted by

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sales weighted fuel efficiency in the place of the unadjusted price. We find that the sales elasticity with respect to adjusted gas price (-.2) is much lower (by a factor of about three) than the elasticity with respect to the unadjusted price.

This elasticity implies that a 1% rise in fuel efficiency for new cars (or an equivalent decline in gas price) causes a 0.2% rise in sales. Possible errors in variables due to errors in estimated fuel efficiency over time, and the use of annual data rather than quarterly may tend to make our model undersensitive to price changes. Thus, we would view our result as a lower bound for the gasoline price elasticity, with the unadjusted elasticity of -.8 as a reasonable upper bound.[1]

Simulations using the TSC sales model show no negative effects on auto industry sales for reasonable combinations of higher new car prices, efficiency improvements and gasoline costs. In fact, the slight gains in sales over the baseline which our model forecasts are consistent with the study's findings that new car price increases are more than compensated for by fuel savings deriving from the technological improvement. It should be noted that these results utilize the conservative fuel price elasticity of the TSC model. If the higher elasticities of the Chase estimates could properly be used as fuel expenditure elasticities, then sales would be far above the baseline for most scenarios considered.

The price and fuel efficiency changes also affect the relative numbers of cars purchased in the various size classes. Tables 6-9 give the projected sales percentage for various size classes of vehicles under different assumptions. All calculations except Scanario D were made using the DOT/TSC in-house shares model.[2]

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[1] Chase Econometric Associates, Inc., The Effect of Tax and Regulatory Alternatives on Car Sales and Gasoline Consumption, May 1974.

[2] This model uses the sequential binary logit formulation. See "A Preliminary Model of Auto Choice by Class of Car: Aggregate State Data," by Charlotte Chamberlain, Report DP-SP-28 (January, 1974).

TABLE 6. ESTIMATED PERCENT OF CAR PURCHASE BY SIZE CLASS

(UNDER SCENARIO A, 1972 - 1985)

	SUBCOMPACT	COMPACT	INTERMEDIATE	STANDARD	LUXURY[1]
1972	19	13	21	35	12
1974	22	17	24	29	8
1975	21	16	22	31	10
1980	20	12	20	33	15
1985	20	10	20	33	17

TABLE 7. ESTIMATED PERCENT OF CAR PURCHASES BY SIZE CLASS

(UNDER SCENARIO B, 1972 - 1985)

	SUBCOMPACT	COMPACT	INTERMEDIATE	STANDARD	LUXURY[1]
1972	19	13	21	35	12
1974	22	17	24	29	8
1975	21	16	22	31	10
1980	20	12	20	33	15
1985	19	9	18	35	19

1) The DOT/TSC shares model included a sizable number of larger and more expensive "standard" vehicles, e.g., some Mercurys, Dodges, Buicks, Oldsmobiles, and Pontiacs in the luxury car class.

TABLE 8. ESTIMATED PERCENT OF CAR PURCHASES BY SIZE CLASS

(UNDER SCENARIO C, 1972 - 1985)

	SUBCOMPACT	COMPACT	INTERMEDIATE	STANDARD	LUXURY[1]
1972	19	13	21	35	12
1974	22	17	24	29	8
1975	20	15	22	32	11
1980	19	10	19	35	17
1985	19	9	18	35	19

TABLE 9. ESTIMATED PERCENT OF CAR PURCHASES BY SIZE CLASS

(UNDER SCENARIO D, 1972 - 1985)

	SUBCOMPACT	COMPACT	INTERMEDIATE	STANDARD	LUXURY[1]
1972	19	13	21	35	12
1974	22	17	24	29	8
1975	25	20	24	24	7
1980	40	25	25	6	4
1985	40	25	25	6	4

1) The DOT/TSC snares model included a sizable number of larger and more expensive "standard" vehicles, e.g., some Mercurys Dodges,Buicks,Oldsmobiles,and Pontiacs in the lu ury car class.

Price increases used were the DRI[1] forecast of 1975-1985 new car price (baseline) plus the added price increases developed for the different scenarios. The results are easy to interpret. Since the absolute price increases are small relative to the growth in real income and other prices, gains in fuel efficiency reduce operating costs and tend to induce consumers to shift their purchases towards the larger cars. Note that the shifts to larger cars are greater for those cases which have the larger increases in fuel efficiency.

These results, together with expected increases in aggregate sales, indicate that there are some favorable impacts on the auto industry if fuel efficiency is increased. In particular, the improving sales of larger vehicles coupled with an upward trend in total sales would be a favorable development since large cars and volume are though to have positive effects on profits. The relative improvement in sales of larger vehicles also means that the industry will not have the future problem of changing additional production facilities to produce small cars instead of the larger cars, except in the special case of Scenario D.

4.2 CAPITAL INVESTMENT CAPABILITY AND REQUIREMENTS

Recapitulating the findings of the Technology Panel, Table 10 below summarizes the cumulative investment costs of the efficiency improvements likely to be accomplished by 1985.

The values shown in Table 10 were calculated as follows:

Scenario A represents engine improvements implicit in the dual catalyst systems required to meet the .4 gram/mile NOx standard, plus minor weight reductions which can be made at little or no capital cost, plus radial tires (whose investment burden is being borne by the tire industry).

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[1]Data Resources Incorporated, Lexington, MA., May 1974.

TABLE 10. INCREMENTAL CAPITAL SPENDING SCENARIOS FOR DOMESTIC AUTO MANUFACTURERS (millions of 1974 dollars)

SCENARIO		A	B	C	D
1975		-0-			
1976		25	25	175	-
1977		25	100	175	445
1978		-0-	75	175	445
1979		-0-	240	175	560
1980		-0-	580	175	950
1981		-0-	540	-	540
1982		-0-	540	-	540
1983		-0-	540	-	540
1984		-0-	520	-	520
1984		-0-	500	-	520
1975-1980	TOTAL	50	1020	875	2400
1975-1985	TOTAL	50	3660	875	5040

Scenario B includes all of Scenario A plus the retooling of four lines per year to build 4-speed transmissions with lockup (about $75 million/year from 1977 through 1980); expenditures totaling $360 million in the 1979-81 period for conversion of 12 conventional engine lines to stratified charge configuration (mainly for smaller cars); expenditures of $420 million per year beginning in 1980 for the construction of diesel engine lines (3 per year); the remainder was associated with the transition to unitized body assembly procedures.

Scenario C includes Scenario A plus the retooling of four transmission lines per year in 1976 through 1980 ($75 million per year) plus the resizing of five conventional engine lines per year ($100 million/year).

Scenario D comprises Scenario B plus a major shift to smaller cars requiring each year (1977 to 1980) one brand new subcompact assembly plant (@ $150 million), two conversions of existing large car assembly plants (@ $35 million); and three conversions of engine plants to a 4-cylinder product (@ $50 million). The extreme peak in 1980 could be avoided by deferring the startup of diesel production by one year.

The cost figures described above are thought to be conservative, i.e., it may be possible to achieve many of the plant conversions at considerably lower costs than the values shown. For example, rather than building all new tooling for diesels at $140 million per line, it may be possible to convert existing V-8 lines for as little as $50 million per line.

In addition to the above, capital expenditures must made in several other categories: The industry has announced plans to bring out a number of new models of small cars at a cost of at least $50 million per model. Compliance with Clean Air requirements will call for the investment of about $50 million more by 1978 mainly for (proportional exhaust gas recirculation) valves and intake manifold changes.[1] The 1978 bumper standards may require capital investment of about $150 million. If air bags are required for future cars, some $200 million must be invested in their production facilities, although the great bulk of that investment will be made by fabricators of components (textiles, electronics, valves, etc.,) rather than the auto industry. To offset rising wage costs, a great deal of the industry's capital plant should be replaced whether or not technical changes are being made in the vehicles produced.[2] Finally, since sales are currently expected to rise again over the remainder of this decade, capital will be needed for expansion.

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[1]The great bulk of the investment for air pollution control, about $550 million, has already been made.

[2]About a third of the assembly plants were built before WWII.

Quantification of these latter items is difficult since they are in large measure discretionary. While manufacturers would probably prefer to spend their capital budgets for modernization and expansion, faced with sufficient pressure from government and/or consumers, they will necessarily delay such projects enough to accommodate fuel economy improvements. Indeed, from their published statements it would appear that they have already modified their investment plans to achieve most of the near-term improvements described in the Technology Panel Report.

To place these anticipated capital expenditures in some perspective, Table 11 below shows the dollar amounts of capital spending of the major domestic motor vehicle manufacturers during the past two years.

TABLE 11. GROSS CAPITAL EXPENDITURES OF MAJOR DOMESTIC VEHICLE MANUFACTURERS[1]

(thousands of dollars)

	1973	1972
AMC	68,426	32,067
Chrysler	628,166	334,900
Ford	1,486,000	1,204,800
GM	2,104,399	1,838,580
Total	4,286,991	3,410,347

It must be noted that the figures above represent a consolidation of all forms of capital spending for all lines of business in which these companies engage. Until Federal statutes mandating "by line of business" financial reporting take effect, detailed information regarding investment in passenger car production will not be available. It is generally surmised, however, that about two-thirds of the above gross investment is passenger car related.

[1] Moody's Industrial Manual, 1974

Furthermore, the above figures include not only plant and equipment (with service lines of 10 years or more) but also the special tools, fixtures, jigs, etc., which are specific to a particular product and which must be scrapped when that particular product is withdrawn from the market. Although exact spending for such items was not available, they are thought to be approximately equal to amortization costs, which are published by Moody's and shown in Table 12.

TABLE 12. AMORTIZATION OF SPECIAL TOOLS[1]
(thousands of dollars)

	1973	1972
AMC	20,636	23,260
Chrysler	191,900	196,100
Ford	463,100	458,300
GM	1,081,021	874,223
Total	1,756,657	1,551,883

Thus capital spending with regard to the longer lasting items has been running at something on the order of $2.5 billion per year, which is rougly consistent with the values given in the McGraw-Hill Capital Spending Survey, Spring 1974:

Year	Plant & Equipment Spending by Manufacturers of Autos, Trucks and Parts (Billions of 1974 Dollars)
1973	2.28
1974	2.55
1975	2.04
1976	2.39
1977	2.44

[1]Moody's Industrial Manual, 1974

Since the investments shown in Table 10 amount to only a small fraction of the industry's total planned spending for plant and equipment, it is certainly possible that the motor vehicle industry will be able to implement fuel economy improvements without encountering significant financial problems. However, it must be recognized that individual firms could have problems in raising investment funds (for any purpose) if sales were to decline and remain low for a protracted period. Investment problems would be most severe for the weaker members of the industry, particularly American Motors and Chrysler. Still if long term sales meet the forecasts of modest growth, it is likely that fuel economy related investments can be funded as substitutes for, rather than as additions to, the capital spending projects contemplated before the energy crisis, especially in place of expenditures intended to ex-expand production of larger cars.

5. OTHER INDUSTRY IMPACTS

Previous studies[1,2] have shown that the major supplier industries, e.g., steel, rubber, batteries, electrical equipment, stampings, machinery, etc., can suffer at most a loss of only a few percent of their sales in even the most disruptive scenarios of conversion to alternative engines or other high-efficiency automotive technology. These losses are associated with scenarios in which there are sales reductions and very sharp increases in car prices (i.e., greater than $1000) attributable to taxes and/or to the incorporation of exotic technology. However in the scenarios which this report envisions, total auto sales expressed in terms of both units and real dollars increase because of fuel efficiency improvements, so that impacts on supplier industries are generally favorable.

The above notwithstanding, scattered hardships will occur, primarily among certain smaller business who supply relatively specialized components; e.g., optional and aftermarket equipment for "high performance" cars. While most of these have shown considerable ability to adapt to changes in the markets they serve, some of these firms may encounter severe problems.

Our projections of passenger car gasoline consumption under various scenarios (see below) show growth rates ranging from essentially flat to about -4% per annum around 1980 --far below the +5% rates characteristic of the early 1970's. This easing of demand pressure will relieve the petroleum industry of a significant portion of the enormous capital investment requirement it now faces. If, for example, by 1985 gasoline savings amounted to 15

[1] The Effect of Tax and Regulatory Alternatives on Car Sales and Gasoline Consumption, Chase Econometric Associates, May 1974

[2] A Study of Mass Produced Advanced Automotive Power Systems, International Research and Technology Corp., December 1972.

billion gallons per year (or about 1 million barrels per day) petroleum investment requirements would be reduced by about $12 billion.[1]

In scenarios B and D, which involve the introduction of diesel engines, additional impacts fall on the petroleum industry as refineries are reconfigured to produce a higher fraction of diesel fuel and distribution facilities are added. Although the industry has only a limited ability to shift its product mix in the short run, over the twenty-year period in which diesels would be phased into the fleet, no insurmountable problems should arise. In fact, it is well known that refinery investment per unit of throughput in Europe is somewhat lower than the average in the U.S., in part because European refineries produce only about 25% of their output as gasoline, whereas in the U.S. more than 45% is gasoline. A lower gasoline yield requirement reduces the need for certain processing steps, such as catalytic cracking, along with their capital costs. The distribution of diesel fuel may require some additional investment, but there are several possibilities for minimizing this impact, e.g., most service stations could restrict themselves to supplying only two or three of the fuels in use.

[1] Based on current estimates of investment costs for production on the outer continental shelf.

6. FOREIGN TRADE AND MACROECONOMIC IMPACTS

6.1 OIL CONSUMPTION AND POTENTIAL BALANCE OF TRADE IMPACTS

Projections of total passenger car fuel consumption in future years under alternative technology scenarios are given in Table 13 below. These projections take into account the expected shift towards larger cars as fuel efficiency is improved as well as fuel efficiency improvements themselves. All projections (including the baseline) assume that vehicle miles travelled (VMT) will increase at 2.6% per year.[1] While dramatic savings in petroleum requirements can result from fuel economy improvements to motor vehicles, the savings in petroleum shown here may not be fully realized since the resulting gains in operational economy may induce some additional travel.[2]

TABLE 13. ANNUAL FUEL CONSUMPTION IN PASSENGER CARS
(billions of gallons)

Year		Scenario			
	Baseline	A	B	C	D
1975	81.0	79.5	79.6	79.1	79.0
1980	93.8	80.8	80.1	76.6	73.1
1985	107.2	85.6	78.2	76.8	66.0
1990	122.0	96.1	80.0	84.6	66.8

[1] "Transportation Energy Conservation Options", by D. Rubin, J.K. Pollard, et al., U.S. Department of Transportation, Transportation Systems Center, Oct. 1973. (Draft Report), p. 3-6.

[2] Some additional calculations were made using gas price elasticity as an estimate of the responsiveness of VMT to changes in fuel efficiency. Although the savings shown in Table 14 were reduced, the results were similar, e.g., the scenario C savings for 1980 were reduced from 1.2 to 0.95 millions of barrels per day.

Table 14 provides the estimated savings in crude oil for each scenario expressed in millions of barrels per day(MBD). The savings given are simply the difference in consumption between the baseline and the relevant scenario with an adjustment for refining losses and a shift in the unit of measurement. Although more than two barrels of crude oil are required to produce one barrel of gasoline (along with a barrel of other products). Over the lengthy period during which more efficient cars will be phased in, it is assumed that the petroleum industry will be able to make any adjustments necessary to reoptimize its product mix so that each barrel of fuel saved is considered equal to only one barrel of crude, adjusted for refining and distribution losses (estimated at 10% in 1980).

TABLE 14. NET SAVINGS OF CRUDE OIL
(millions of barrels/day)

Year		Scenario			
	Baseline	A	B	C	D
1975	0	0.1	0.1	0.1	0.1
1980	0	0.9	1.0	1.2	1.5
1985	0	1.6	2.1	2.2	3.0
1990	0	1.9	3.0	2.7	4.0

Table 15 provides estimates of the annual dollar savings which correspond to the crude oil savings of Table 14. The $11/bbl used to value the savings is based on the approximate import price, and therefore the savings represent potential improvements in the U.S. balance of payments (assuming that the U.S. remains dependent on imports for some portion of its petroleum supply throughout the 1980's). Even if imports are reduced

or eliminated the savings accrue as reduced domestic output of oil which also would cost $9 to $12/bbl to produce and refine.[1]

6.2 MACROECONOMIC IMPACTS

Because of the time constraints in preparing this report, it was not possible to use a general macroeconomic/econometric model to integrate fuel economy changes into forecasts for comparison to a baseline. However, the potential macroeconomic impacts of automotive fuel economy improvements on car prices, car sales, automotive investment, automotive employment, and U.S. international trade were examined briefly. Information relating to impacts on these individual variables suggest that the macroeconomic effects are generally limited, except that large improvements in the balance of payments are likely. A brief discussion of these considerations follows.

6.2.1 Car Price

The initial real price of new cars may rise by 5% to 10% as a result of fuel economy improvements.[2] Since the analysis indicates fuel savings would exceed the new car price increases, the real cost of automobile ownership due to fuel economy improvements would be reduced.

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[1] "Executive Summary" From Project Independence Report, Presented by Federal Energy Administration, Nov. 12, 1974, to Presidents Energy Resources Council" (Bureau of National Affairs, Inc.; Washington, 1974), (No. 66) page B-7.

[2] Little effect on the Consumer Price Index, however, would be expected since, in its calculation, the Bureau of Labor Statistics eliminates costs for "product quality improvement"

6.2.2 Automobile Sales

The analysis indicates that automobile sales may be increased by the fuel economy improvements contemplated in this report. The likely impacts are probably no more than 200,000 cars per year more than would be the case had no economy improvements been made. Such sales changes are quite small in comparison to the fluctuations of more than 2,000,000 units associated with the business cycle.

6.2.3 Employment Effect

There is no evidence to suggest that improvements in fuel economy of automobiles would have a significant long term effect on employment in the auto industry because of the favorable sales effects noted above.

6.2.4 Macroeconomic Investment Impact

The rate of investment required for the most capital intensive automobile fuel economy improvements considered is estimated to be about one-half billion dollars per year, which is less than 1% of the total annual U.S. investment in plant and equipment.

6.2.5 Impact on U.S. Foreign Trade

The interrelationships between fuel economy improvements, foreign trade balances, and the general level of economic activity are complex. However, two foreign trade consequences of U.S. automobile fuel economy improvements are identifiable. First there would be reductions in U.S. oil imports that could dramatically alter the U.S. balance of trade and provide further funds for domestic investment and consumption. Secondly, fuel economy improvements in U.S. autos could improve their competitive position relative to foreign imports and thereby bring a further reduction in U.S. imports.

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16. Abstract

This Economics Panel Report is Number Five (5) of a group of seven (7) prepared by special panels of the Task Force established under the joint chairmanship of DOT and EPA to conduct a study of the practicability of a fuel economy improvement standard of 20% for new motor vehicles produced in the 1980 time frame.

This report analyses the economic effects automobile fuel economy improvement will have on the automobile industry, the American consumer, and the U.S. economy in general. Some specific conclusions are that

1. Consumers will generally experience savings on fuel and maintenance expenditures which more than offset the increases in car prices due to the fuel economy improvements.

2. Automobile sales are expected to increase in the 1970's and 1980's although the rate of increase is expected to be slower than in the past, with a shift back towards standard-size cars.

3. Petroleum savings could range from 0.9 to 1.5 million bbl/day by 1980, from 1.6 to 3.0 by 1985 and from 1.9 to 4.0 by 1990.

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